



Materials and Coatings

Durable Aerogel Technologies

For thermal insulation and lightweight structures

NASA-developed polyimide aerogels are 500 times stronger than conventional silica aerogels. The innovation represents a revolutionary advance over fragile silica aerogels because it is highly flexible and foldable in thin film form. As a thin film, it can be used to insulate industrial pipelines, automotive shields, temporary housing structures, and within protective clothing such as firefighting jackets, space suits, and parkas. As a thicker part, it can be easily molded to a shape, or sanded and machined to provide insulation as well as mechanical support. No other aerogel possesses the compressive and tensile strength of the NASA innovation while still retaining its ability to be flexibly folded to contour to whatever shape is needed.

BENEFITS

- ➔ Thin and flexible - can be manufactured in a flexible form yet maintain excellent tensile properties
- ➔ Strong - 500 times stronger than traditional silica aerogels; thick panels can be used as multifunctional insulation
- ➔ Versatile - can be custom manufactured as molded shapes and thin films
- ➔ Low thermal conductivity - 2 to 10 times improved performance over polymer foams in ambient condition and up to 30 times improved performance in vacuum conditions
- ➔ Heat resistant up to 200 to 300°Celsius for long-term use
- ➔ Moisture resistant

technology solution



NASA Technology Transfer Program

Bringing NASA Technology Down to Earth

THE TECHNOLOGY

Aerogels are highly porous, low-density solids with extremely small pore sizes, making them superior insulators. However, most silica aerogels are fragile. The NASA Glenn team is the first to synthesize polyimide aerogels by cross-linking through an aromatic triamine or polyhedral oligomeric silsesquioxane, octa-(aminophenyl)silsesquioxane, and chemically imidizing at room temperature. The result is a cross-linked polyimide aerogel that retains the beneficial characteristics and strength of polyimide materials and adds the beneficial properties of aerogels, but without the brittle and fragile nature of silica aerogels. Silica aerogels on the market now are available in particulate form or as a composite blanket. These aerogels are fragile and shed dust particles. The cross-linked polyimide aerogels have much better mechanical properties than silica aerogels and do not shed dust particles. They can be fabricated or machined into net shape parts, which are strong and stiff, or cast as thin flexible films with good tensile properties. Extremely customizable, the innovation can be formed into any configuration (e.g., wrapped around a pipe, sewn into protective clothing, or molded into a panel to act as a heat shield in a car). For example, a square "patch" antenna fabricated on a customized low density, low dielectric constant polyimide aerogel substrate exhibits larger bandwidth, lower mass, and superior implementation capability than conventional antennas designed for the same frequency of operation. The polyimide aerogel antenna can be tailored regarding composition, porosity, thickness, dielectric constant, and radio frequency (RF) transmission losses, which allows for optimization of bandwidth, impedance matching, and gain, which are critical for improving aerospace communication systems. The use of flexible aerogel substrates in the antenna design would enable antennas to be wrapped for conformal/curved surfaces such as aircraft wings and fuselage, sounding rockets (nanosats), missile cones, etc. Non-aerospace applications could include automotive (e.g., collision avoidance systems), radio frequency identification (RFID) tags, wearable antennas for short range wireless biomedical applications.



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APPLICATIONS

The technology has several potential applications:

- Thermal insulation for refrigeration, housing, industrial pipelines, automotive, and medical supplies
- Lightweight sandwich structures to reduce weight of automobiles and aircraft
- Antennas low dielectric materials for antennas (aircraft, cell phones, satellites, etc.)
- Filtration media for air and water purification and gas separation
- Flexible, thin insulation for protective clothing, space suits, and shelter applications

PUBLICATIONS

Patent No: 9,309,369; 9,109,088; 8,974,903; 9,356,341

Patent Pending

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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